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Out of black hole's deep throat, a bass note

Discovery of low celestial sound waves may help explain how galaxy clusters regulate their growth.

By Peter N. Spotts | Staff writer of The Christian Science Monitor

Astronomers using the orbiting Chandra X-Ray Observatory have discovered a powerful "basso profundo" adding its notes to the music of the spheres.

The international team has detected sound waves generated by an enormous black hole at the center of one of the most massive galaxies known to astronomy. At 57 octaves below middle C on a piano, the black hole's "hum" is the lowest pitch ever detected from a celestial object.

That's more than 300,000 trillion times lower than James Earl Jones's voice - a frequency barely even detectable by the galaxies it ripples through, much less by the human ear.

The discovery, however, represents "much more than just an interesting form of black-hole acoustics," notes Steve Allen, an astronomer at Britain's Institute of Astronomy in Cambridge, England, and a member of the team reporting the find. The sound waves may help govern the growth of some of the largest structures in the universe, such as galaxy clusters - collections of thousands of galaxies corralled by their combined gravity.

The acoustic waves were detected as differences in density within an envelope of gas that surrounds the Perseus cluster. The cloud is so hot - 30 million to 70 million degrees F. - that it only is visible at X-ray wavelengths. The cluster stretches some 250 million lightyears across. The humming black hole lies at the heart of the cluster's central galaxy, known as NGC-1275, and is estimated to tip the scales at more than a billion times the sun's mass.

At a science briefing Tuesday at NASA headquarters in Washington, the team, led by the Institute of Astronomy's Andrew Fabian, explained that these acoustic waves are probably generated by powerful, tightly focused jets of charged particles that stretch for thousands of light years beyond the galaxy's core.

The jets - themselves the subject of intense research - are thought to be generated when matter swirling into the black hole forms an accretion disk. The dust and gas in the disk get compressed, and heat to millions or even billions of degrees.

At these temperatures, the matter turns into a roiling soup of high-energy particles. Some of those particles interact with the disk's magnetic field and get hurtled into space at nearly the speed of light, above and below the accretion disk and along the black hole's axis of spin.

As the jets snake and pulse, they punch vast bubbles into the surrounding gas, setting up shock waves that continue to travel through the intergalactic envelope of gas.

The result is a bit like a series of cosmic thunderclaps, notes Kim Weaver, an astrophysicist at

NASA's Goddard Space Flight Center in Greenbelt, Md.

Besides the novelty of NGC-1275's stentorian "hum," the find appears to be shedding light on a long-standing mystery: What regulates the sizes of galaxies, groups of galaxies, and galaxy clusters?

Astronomers note that the glowing gas surrounding the Perseus cluster contains enough material to build thousands of additional galaxies. In principle, Dr. Weaver says, the gas should cool, contract, clump, and begin the star- and galaxy-formation process. Instead, while the envelope is somewhat cooler toward the center, as one might expect, astronomers don't see the level of star formation they expect.

Researchers have proposed a number of mechanisms for keeping the gas hot and diffuse enough to thwart the formation of vast amounts of new stars. One key suspect has been the bubbles. But the mechanism by which the bubbles heat the surrounding gas is unclear.

Dr. Fabian and his team propose that the acoustic waves, which carry a great deal of the energy, heat the gas and counteract its tendency to contract - in effect shutting off any wide-scale star birth.

"That's why this is so important," Weaver says.

"The supermassive black hole almost seems to know how much gas there is and is reacting to its environment. We're getting a hint of self-regulating mechanisms [to galaxy and cluster growth] that may involve supermassive black holes."

Relative frequency

The sound coming from the black hole at the center of the Perseus galaxy cluster has a pitch about 57 octaves below middle C. (The piano note has a pitch of 278 Hz, or vibrations per second.) To put that into perspective, consider these frequencies:

Mel Gibson's voice: 108 vibrations per second

Lowest audible sound for humans: 20 vibrations per second

lowest audible sound for elephants: 1 vibration per hour

Perseus cluster's emission: 1 vibration per 10 million years

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